Limnological Studies of Certain Flood Prone Pond of North Bihar Region with Special Reference to Pollution

Synopsis

Submitted in partial fulfillment of the requirements
for the award of Ph.D. degree in Zoology, Under
the Faculty of Science,
Lalit Narayan Mithila University,
Darbhanga

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Introduction

The North Bihar region is characterized by its extensive network of ponds, which play pivotal roles in the local hydrology, biodiversity conservation, and socio-economic activities. However, these ponds are susceptible to recurrent flooding, exacerbating pollution issues due to the influx of contaminants from surrounding terrestrial sources. Despite their ecological significance, there is a notable dearth of comprehensive studies focusing on the limnological aspects of these flood-prone ponds, particularly concerning pollution dynamics. Therefore, this research seeks to fill this gap by conducting a systematic investigation into the limnological parameters and pollution levels in select ponds of the North Bihar region. Ponds are small, man-made or natural shallow water bodies which are permanently or temporarily hold water (De Meester et al, 2005). When the ecosystem is balanced, a properly designed and built pond require little maintenance. A variety of natural, and fish friendly materials are available from those times when an adjustment is needed to keep the ecosystem in balanced state. The sign of well - balanced pond include healthy fish, clean water, thriving plants, lest BOD and minimal pests.

The flood prone ponds are subjected to various alternations in their physico –chemical features due to floods effecting on the quality and purity of soil and water, ultimately causing adverse ecological condition for the inhabiting organisms. North Bihar is identified by planning commission as one of the disadvantaged area, mainly facing challenges of water resource development and management, frequent floods and water logging, rampant soil erosion and poor condition of aquaculture which causes adverse effect on the economy of the region of Bihar.

Limnology has greatly influenced the field of fresh water fisheries science. Particularly fisheries. Biology-Limnology remains important to capture some of the dynamics inherent in socio-ecological fisheries system. For understanding how aquatic system functions in complex situation due to floods. How floods causing effects on the chemicals in the water and in the sediments and how the population of aquatic organisms are subjected to the pollutants need to be investigated in North Bihar.

Review of Literature

Water is the most vital resource for all kinds of life on this planet. With this fact at its core, concerns for the freshwater life arose in the remote past. From the time of Forel (1841 – 1912), who is regarded as the founder and father of limnology, freshwater phenomenon was observed and recorded. Limnology is the branch of science that deals with the biological productivity of inland waters with all the causal influences which determine it. The pioneer investigations of Forel 1982 were focused on Le Leman (Lake Geneva) where he exposed the preliminary facts concerning the fauna of freshwater. Then limnology was studied with reference to organisms, especially plankton. The discovery of plankton by Victor Hansen in 1887 was an outstanding event in the field of limnology. In India, investigation by Prasad on the seasonal variation of pond organisms was conceivably the first limnological study. Curiosity instigates scientists to find out the facts of limnology and hence work on different aquatic bodies have occurred occasionally. Detailed account of the physico-chemical conditions of a particular aquatic body has been given by a few some scientists, similarly, some scientists have discussed the distribution of biological conditions, and others have observed the interrelationships of these factors on the growth and development of

zooplankton and fish. The researchers have also laid stress on the algal blooms. Physicochemical parameters: indicators of water health Good quality of water is prerequisite for the survival of living organisms.

Hence, it is necessary to check the quality of drinking water at regular interval of time, as the prolonged use of contaminated drinking water leads the human population to suffer from various water borne diseases. The quality of water deteriorates day by day because of vast population, ignorance and negligence of the human being. Quality of water can be determined by studying its physicochemical characteristics; since, environmental pollutants affect the aquatic ecosystem in a synergistic manner, the extent of pollution cannot be estimated just by relying on the physicochemical characteristics. As the biological system can combine all environmental variables over a period of time, its effects can be measured and is thus well suited for getting the gathering information regarding the level of pollution.

In this synopsis, both the physico chemical as well as biological parameters representing the quality of pond water of Bihar has been reviewed with work carried out in the past by scientists and academicians who have done extensive work related to the quality of water. The physicochemical characteristics of water, that include total dissolved solids, dissolved oxygen, turbidity, temperature and hardness etc., mainly influence productivity of water. Various research works on water quality has been discussed by different researchers both from India and abroad.

Nag et al. have analyzed the physicochemical parameters of the pond located in Darbhanga town of Bihar. Their results revealed that there was significant seasonal variation in some physicochemical parameters and the water was moderately polluted in Darbhanga town, Bihar. On the basis of this primary study, it was apparent that water was not potable. Total

dissolved solids and total suspended solids were maximum in summer season, due to sewage water and suspended substances from the surrounding. High phosphate levels signify high degree of pollution. The value of Biological Oxygen Demand suggests that the pond is eutrophic. Increase in Chemical Oxygen Demand during summer season is correlated with the decomposition of suspended organic matter which releases the soluble organic matter in the water.

Simpi *et al.* (2011) studied water quality using physico-chemical parameters Hosahalli Tank in Shimoga district, Karnataka.

Research conducted by Maria-Heleni and colleagues (2000), examined the zooplankton diversity within River Aliakmon in Greece. They documented a total of 79 species of zooplankton and noted that the diversity of zooplankton was impacted by several abiotic factors, including temperature, dissolved oxygen levels, as well as nitrogen and phosphorus concentrations.

Twenty-five ponds of the three blocks of Araria district, Bihar was studied from June 2011 to May 2012 by Narayana et al. The physical and chemical properties they studied include pH, temperature, transparency, free CO2, dissolved oxygen, total alkalinity and total dissolved solids. They found that the pH was little alkaline and confirmed with the water quality standards given by Central Pollution Control Board, New Delhi. However, level of total alkalinity increased during the rainy season. That is mainly because of the decomposition of biological organisms. The higher values of TDS during rainy season might be due to the discharge of domestic waste water and garbage etc. in to the ponds. In addition, the DO values measured at different ponds were in B or C category of water quality criteria

given by Central Pollution Control Board, New Delhi, indicating that water was safe for bathing and even drinking after conventional treatment.

Objectives

Based on the review of literature the present study was undertaken with the following objectives:

1. Study the diversity of biotic and abiotic factors with special reference to the geospatial orientation i.e. ponds of northern Bihar. Also, the duration of the study would be 24 months (all different seasons) and precisely during flooding (June and July).

1. Characterize the limnological parameters (e.g., pH, dissolved oxygen, nutrient levels) of flood-prone ponds in the North Bihar region to establish baseline conditions. And Identify and assess the sources of pollution (e.g., agricultural runoff, industrial discharge, domestic sewage) affecting the water quality of these ponds.

2. Quantify the concentrations of pollutants (e.g., heavy metals, pesticides, organic compounds) present in flood-prone ponds and evaluate their spatial and temporal variability.

3. Investigate the effects of pollution on aquatic biota, including phytoplankton, zooplankton macroinvertebrates, and fish communities, within flood-prone ponds.

4. Assess the ecological health and resilience of flood-prone ponds in relation to pollution levels, with the aim of providing recommendations for sustainable management and conservation strategies.

Plan of work and methodology

1. Study Design and Site Selection:

- Conduct a comprehensive survey to identify flood-prone ponds across the northern Bihar region.
- Select representative ponds based on their geo-spatial orientation, considering factors such as size, connectivity to floodplains, and proximity to human settlements.
- Ensure coverage of diverse pond types, including natural ponds, agricultural ponds, and urban ponds, to capture variability in environmental conditions.

2. Sampling Strategy:

- Implement a longitudinal study design spanning 24 months to capture seasonal variations in limnological parameters and pollution levels.
- Schedule sampling expeditions during flooding periods (June and July) to assess the influence of flood events on pond dynamics and water quality.
- Collect water samples from multiple locations within each selected pond, ensuring spatial representativeness.

3. Limnological Parameter Analysis:

- Measure key limnological parameters, including pH, dissolved oxygen (DO), temperature, conductivity, turbidity, and nutrient levels (nitrogen and phosphorus species).
- Utilize standardized protocols and equipment for accurate data collection and analysis.
- Establish baseline conditions by comparing parameter values across different seasons and pond types.

4. Pollution Source Identification:

- Conduct field surveys to identify potential sources of pollution in the vicinity of the sampled ponds, including agricultural areas, industrial zones, and residential settlements.
- Collect water samples from inflow points and adjacent land-use areas to assess pollutant inputs.
- Employ geographic information system (GIS) techniques to map spatial distribution of pollution sources and their proximity to sampled ponds.

5. Pollutant Concentration Analysis:

- Analyze water samples for the presence and concentrations of pollutants, including heavy metals, pesticides, and organic compounds, using appropriate analytical techniques such as spectrophotometry, chromatography, and atomic absorption spectroscopy.
- Evaluate temporal variability in pollutant levels by comparing data obtained during different sampling periods.

6. Ecological Impact Assessment:

- Conduct biological assessments to investigate the effects of pollution on aquatic biota within sampled ponds.
- Collect plankton samples to assess phytoplankton and zooplankton community composition and abundance.
- Conduct macroinvertebrate sampling using standardized methods such as kick-net sampling or sediment core extraction.
- Assess fish community structure and health through fish surveys, including species richness, abundance, and condition indices.

7. Data Analysis and Interpretation:

- Analyze collected data using statistical methods to identify patterns, trends, and correlations.
- Integrate limnological, pollution, and biological data to assess the relationship between water quality, pollution levels, and ecological health.
- Interpret findings in the context of existing literature and scientific knowledge to draw conclusions about the status of flood-prone ponds in the North Bihar region.

By following this comprehensive plan of work and methodology, the research aims to achieve its objectives of studying the diversity of biotic and abiotic factors, characterizing limnological parameters, assessing pollution sources and concentrations, investigating ecological impacts, and providing recommendations for sustainable management of floodprone ponds in North Bihar.

Finding water quality index of different area of north Bihar by analyzing different

criteria:

pH: The pH (Potential Hydrogen) of a solution refers to its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion activity at a given temperature. The permissible limit of pH in drinking water is within 6.5 – 8.5 according to Bureau of Indian Standard (BIS).

Electrical conductivity: Electrical conductivity (EC) is the ability of an aqueous solution to conduct the electric current. Electrical Conductivity is a useful tool to evaluate the purity of water [7]. The most desirable limit of EC in drinking water is prescribed as 1.500 µs/cm.

Total dissolved solids (TDS) denote mainly the various kinds of minerals present in water. The permissible value recommended for TDS is 500 mg/l prescribed by IS 10500 and BIS, FAO.

Dissolved oxygen The presence of dissolved oxygen is essential to maintain the higher forms of biological life and to keep proper balance of various pollutions thus making the water bodies healthy. The chemical and biochemical process undergoing in water body are largely dependent upon the presence of oxygen. Estimation of dissolved oxygen is a key test in water pollution and waste treatment process control. The permissible value recommended for DO is 5mg/L as per Indian standard.

Salinity: Salinity is the saltiness or dissolved salt content of a body of water. In the study area, the pond water salinity ranged from 27.9- 70.98 ppm which are well within the drinking water quality standards.

Temperature: Temperature is one of the most important factors in the aquatic environment [9]. It affects the physical and chemical properties of water and also affects the aquatic vegetation, organisms and their biological activities. Temperature values in the ponds in the study area ranged from 26.8 to 29.6°C. Choudary et al., [10] study the ponds of Sasaram, Bihar observed the temperature range varies from 23 to 27degree C.

Total metals and hardness of water present will be analyzed.

After collecting the data from different places, the **correlation and regression** will be analyzed. this is to check about the differences and similarity and probable cause of these parameters.

Hypothesis

The present work is proposed to evaluate limnological features of certain flood prone ponds

of North Bihar, specifically Raiyam Pokhar (Raiyam), Harahi Pokhar (stn, road Daebhanga), Badh Pokhar(Badh Samaila Keoti) and Pacharhi Pokhar are from Darbhanga and Birauli Pokhar (Ox Bow Lake) Birauli, Samastipur in relations to pollution.

- Water temperature: To be measured with centigrade mercury thermometer graded up to 110'C.
- Transparency: To be measured by sacchi disc of 20cm diameter attached to a meter marked plastic tape.
- .pH measurement of Water: To be measured by electric field pH meter.
- Dissolved oxygen: To be estimated according to Winkler's unmodified (Welch 1947)
- Free carbondioxide To be determined by titration of sample with N/44 NaOH solution and phenolphthalein as indicator.
- Dissolved hydrogen Sulphide To be estimated by standard method (APHA. 1980)
- Chloride : To be estimated by titration using 0.2N Silver nitrate as titrant and 5% K2 Cr04 solution as indicator.
- Silicate: By colorimetric method.
- Alkalinity To be measured by titration phenophthalein indicator with N/50 H2So4.
- Phosphate content: To be estimated by photo electric coloremeter.
- Total Nitrogen : By Kjeldahi method described by Mishra (1968).
- Chemical analysis of bottom soil : pH by universal indicator method, phosphate content by spectrophotometer.
- Calcium carbonate: By titration (Piper 1950)

• Phytoplankton : Using standard process and calculation of species diversity (Shannonweaver, 1964).

• Zooplankton Standard method for Sampling, preservation and identification.

• Periphyton: By standard methods.

• Micro invertebrates By using Welch (1948) method.

Significance of study

The significance of the study lies in its potential to provide valuable insights into the ecological health and pollution levels of flood-prone ponds in the North Bihar region. By understanding the limnological characteristics and pollution levels, the study can contribute to the development of effective management strategies for preserving these vital aquatic ecosystems and mitigating pollution impacts on local communities and biodiversity. Additionally, the findings can inform policymakers and stakeholders in implementing measures to enhance water quality and resilience to flooding events in the region.

Expected Results

Based on the objectives outlined above, the expected results of this study include:

- Comprehensive data on the physical, chemical, and biological characteristics of the pond's water, providing baseline information for future comparisons and analyses.

- Identification of specific pollutants present in the pond, along with their concentrations and spatial distributions.
- Assessment of the overall water quality status, including parameters such as pH, dissolved oxygen, nutrient levels, and presence of contaminants.
- Insight into the ecological consequences of pollution, including impacts on aquatic flora and fauna.
- Mapping of pollution hotspots within the pond and delineation of potential pathways for pollutant dispersion.
- Recommendations for remedial measures and management strategies to mitigate pollution and restore the ecological balance of the pond.
- Contribution to the scientific understanding of limnological processes in flood-prone areas and their implications for water resource management and environmental conservation.

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